Beginning with Grade 6, Indiana's academic standards for science contain seven standards, with the addition of Historical Perspectives. Each standard is described below. On the pages that follow, age-appropriate concepts are listed underneath each standard. These ideas build a foundation for understanding the intent of each standard.

Standard 1 — The Nature of Science and Technology

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the other. This first standard draws portraits of science and technology that emphasize their roles in the scientific endeavor and reveal some of the similarities and connections between them. In order for students to truly understand the nature of science and technology, they must model the process of scientific investigation through inquiries, fieldwork, lab work, etc. Through these experiences, students will practice designing investigations and experiments, making observations, and formulating theories based on evidence.

Standard 2 — Scientific Thinking

There are certain thinking skills associated with science, mathematics, and technology that young people need to develop during their school years. These are mostly, but not exclusively, mathematical and logical skills that are essential tools for both formal and informal learning and for a lifetime of participation in society as a whole. Good communication is also essential in order to both receive and disseminate information and to understand others' ideas as well as have one's own ideas understood. Writing, in the form of journals, essays, lab reports, procedural summaries, etc., should be an integral component of students' experiences in science.

Standard 3 — The Physical Setting

One of the grand success stories of science is the unification of the physical universe. It turns out that all natural objects, events, and processes are connected to each other. This standard contains recommendations for basic knowledge about the overall structure of the universe and the physical principles on which it seems to run, with emphasis on Earth and the solar system. This standard focuses on two principle subjects: the structure of the universe and the major processes that have shaped planet Earth, and the concepts with which science describes the physical world in general – organized under the headings of *Matter and Energy* and *Forces of Nature*. In Grade 7, students continue to learn about the relationships between physical objects, events, and processes in the universe.

Standard 4 — The Living Environment

People have long been curious about living things – how many different species there are, what they are like, how they relate to each other, and how they behave. Living organisms are made of the same components as all other matter, involve the same kinds of transformations of energy, and move using the same basic kinds of forces. Thus, all of the physical principles discussed in Standard 3 – The Physical Setting, apply to life as well as to stars, raindrops, and television sets. This standard offers recommendations on basic knowledge about how living things function and how they interact with one another and their environment. In Grade 7, students trace the flow of matter and energy through ecosystems.

Standard 5 — The Mathematical World

Mathematics is essentially a process of thinking that involves building and applying abstract, logically connected networks of ideas. These ideas often arise from the need to solve problems in science, technology, and everyday life – problems ranging from how to model certain aspects of a complex scientific problem to how to balance a checkbook.

Standard 6 — Historical Perspectives

Examples of historical events provide a context for understanding how the scientific enterprise operates. By studying these events, one understands that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators. The historical events listed in Grade 7 are certainly not the only events that could be used to illustrate this standard, but they provide an array of examples. Through these examples, students will gain insight into germ theory.

Standard 7 — Common Themes

Some important themes pervade science, mathematics, and technology and appear over and over again, whether we are looking at ancient civilization, the human body, or a comet. These ideas transcend disciplinary boundaries and prove fruitful in explanation, in theory, in observation, and in design. A focus on *Constancy and Change* within this standard provides students opportunities to engage in long-term and on-going laboratory and fieldwork, and thus understand the role of change over time in studying The Physical Setting and The Living Environment.

Standard 1

The Nature of Science and Technology

Students further their scientific understanding of the natural world through investigations, experiences, and readings. They design solutions to practical problems by using a variety of scientific methodologies.

The Scientific View of the World

7.1.1 Recognize and explain that when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often takes further studies to decide.

Scientific Inquiry

7.1.2 Explain that what people expect to observe often affects what they actually do observe and provide an example of a solution to this problem.

7.1.3 Explain why it is important in science to keep honest, clear, and accurate records.

7.1.4 Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.

The Scientific Enterprise

7.1.5 Identify some important contributions to the advancement of science, mathematics, and technology that have been made by different kinds of people, in different cultures, at different times.

7.1.6 Provide examples of people who overcame bias and/or limited opportunities in education and employment to excel in the fields of science.

Technology and Science

7.1.7 Explain how engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems.

7.1.8 Explain that technologies often have drawbacks as well as benefits. Consider a technology, such as the use of pesticides, which helps some organisms but may hurt others, either deliberately or inadvertently.

7.1.9 Explain how societies influence what types of technology are developed and used in fields such as agriculture, manufacturing, sanitation, medicine, warfare, transportation, information processing, and communication.

7.1.10 Identify ways that technology has strongly influenced the course of history and continues to do so.

7.1.11 Illustrate how numbers can be represented using sequences of only two symbols, such as 1 and 0 or on and off, and how that affects the storage of information in our society.

Standard 2

Scientific Thinking

Students use instruments and tools to measure, calculate, and organize data. They frame arguments in quantitative terms when possible. They question claims and understand that findings may be interpreted in more than one acceptable way.

Computation and Estimation

7.2.1 Find what percentage one number is of another and figure any percentage of any number.

7.2.2 Use formulas to calculate the circumferences and areas* of rectangles, triangles, and circles, and the volumes* of rectangular solids.

7.2.3 Decide what degree of precision is adequate, based on the degree of precision of the original data, and round off the result of calculator operations to significant figures* that reasonably reflect those of the inputs.

7.2.4 Express numbers like 100, 1,000, and 1,000,000 as powers of 10.

7.2.5 Estimate probabilities of outcomes in familiar situations, on the basis of history or the number of possible outcomes.

* area: a measure of the size of a two-dimensional region
* volume: a measure of the size of a three-dimensional object
* significant figures: digits that appropriately express the precision of a measurement or quantity derived mathematically from one or more measurements

Manipulation and Observation

7.2.6 Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, or temperatures, and choose appropriate units.

Communication Skills

7.2.7 Incorporate circle charts, bar and line graphs, diagrams, scatterplots*, and symbols into writing, such as lab or research reports, to serve as evidence for claims and/or conclusions.

* scatterplot: a coordinate graph showing ordered pairs of data

Critical Response Skills

7.2.8 Question claims based on vague attributes, such as "Leading doctors say … ," or on statements made by celebrities or others outside the area of their particular expertise.

Standard 3

The Physical Setting

Students collect and organize data to identify relationships between physical objects, events, and processes. They use logical reasoning to question their own ideas as new information challenges their conceptions of the natural world.

The Universe

7.3.1 Recognize and describe that the sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars and that the universe contains many billions of galaxies and each galaxy contains many billions of stars.

7.3.2 Recognize and describe that the sun is many thousands of times closer to Earth than any other star, allowing light from the sun to reach Earth in a few minutes. Note that this may be compared to time spans of longer than a year for all other stars.

Earth and the Processes That Shape It

7.3.3 Describe how climates sometimes have changed abruptly in the past as a result of changes in Earth's crust, such as volcanic eruptions or impacts of huge rocks from space.

7.3.4 Explain how heat flow and movement of material within Earth causes earthquakes and volcanic eruptions and creates mountains and ocean basins.

7.3.5 Recognize and explain that heat energy carried by ocean currents has a strong influence on climate around the world.

7.3.6 Describe how gas and dust from large volcanoes can change the atmosphere.

7.3.7 Give examples of some changes in Earth's surface that are abrupt, such as earthquakes and volcanic eruptions, and some changes that happen very slowly, such as uplift and wearing down of mountains and the action of glaciers.

7.3.8 Describe how sediments of sand and smaller particles, sometimes containing the remains of organisms, are gradually buried and are cemented together by dissolved minerals to form solid rock again.

7.3.9 Explain that sedimentary rock*, when buried deep enough, may be reformed by pressure and heat, perhaps melting and recrystallizing into different kinds of rock. Describe that these reformed rock layers may be forced up again to become land surface and even mountains, and subsequently erode.

7.3.10 Explain how the thousands of layers of sedimentary rock can confirm the long history of the changing surface of Earth and the changing life forms whose remains are found in successive layers, although the youngest layers are not always found on top, because of folding, breaking, and uplifting of layers.

* sedimentary rock: rock formed by compression of successive layers of silt or other small particles

Matter* and Energy*

7.3.11 Explain that the sun loses energy by emitting light. Note that only a tiny fraction of that light reaches Earth. Understand that the sun's energy arrives as light with a wide range of wavelengths*, consisting of visible light and infrared* and ultraviolet radiation*.

7.3.12 Investigate how the temperature* and acidity* of a solution influences reaction rates, such as those resulting in food spoilage.

7.3.13 Explain that many substances dissolve in water. Understand that the presence of these substances often affects the rates of reactions that are occurring in the water as compared to the same reactions occurring in the water in the absence of the substances.

7.3.14 Explain that energy in the form of heat is almost always one of the products of an energy transformation, such as in the examples of exploding stars, biological growth, the operation of machines, and the motion of people.

7.3.15 Describe how electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy, such as light or heat.

7.3.16 Recognize and explain that different ways of obtaining, transforming, and distributing energy have different environmental consequences.

* matter: anything that has mass* and takes up space
* mass: a measure of how much matter is in an object
* energy: what is needed to make things move
* wavelength: the distance between two consecutive, similar points on a wave*
* wave: a traveling disturbance that carries energy from one place to another
* infrared radiation: electromagnetic radiation having wavelengths longer than those of red light but shorter than microwaves
* ultraviolet radiation: electromagnetic radiation having wavelengths shorter than those of visible light but longer than those of x-rays
* temperature: a measure of average heat energy that can be measured using a thermometer
* acidity: a measure of the hydrogen ion concentration in a chemical system

Forces of Nature

7.3.17 Investigate that an unbalanced force, acting on an object, changes its speed* or path of motion or both, and know that if the force always acts toward the same center as the object moves, the object's path may curve into an orbit around the center.

7.3.18 Describe that light waves, sound waves, and other waves move at different speeds in different materials.

7.3.19 Explain that human eyes respond to a narrow range of wavelengths of the electromagnetic spectrum*.

7.3.20 Describe that something can be "seen" when light waves emitted or reflected by it enter the eye just as something can be "heard" when sound waves from it enter the ear.

* speed: the rate per unit time at which an object moves
* electromagnetic spectrum: the arrangement of electromagnetic waves* in order of wavelength and frequency*
* electromagnetic waves: a combination of electric and magnetic fields, each regenerating the other, that carry energy through space – light and radio waves are examples
* frequency: the number of waves that pass a certain point per unit time

Standard 4

The Living Environment

Students begin to trace the flow of matter and energy through ecosystems. They recognize the fundamental difference between plants and animals and understand its basis at the cellular level. Students distinguish species, particularly through an examination of internal structures and functions. They use microscopes to observe cells and recognize that cells function in similar ways in all organisms.

Diversity of Life

7.4.1 Explain that similarities among organisms are found in external and internal anatomical features, including specific characteristics at the cellular level, such as the number of chromosomes*. Understand that these similarities are used to classify organisms since they may be used to infer the degree of relatedness among organisms.

7.4.2 Describe that all organisms, including the human species*, are part of and depend on two main interconnected global food webs*, the ocean food web and the land food web.

7.4.3 Explain how, in sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male and this fertilized egg carries genetic information from each parent and multiplies to form the complete organism.

7.4.4 Explain that cells continually divide to make more cells for growth and repair and that various organs and tissues function to serve the needs of cells for food, air, and waste removal.

7.4.5 Explain that the basic functions of organisms, such as extracting energy from food and getting rid of wastes, are carried out within the cell and understand that the way in which cells function is similar in all organisms.

* chromosomes: a cell structure that contains DNA, a chemical which directs the activities of a cell and passes on the traits of a cell to new cells
* species: a category of biological classification that is comprised of organisms sufficiently and closely related as to be potentially able to mate with one another
* food web: all food chains* in an ecosystem that are connected
* food chain: food and energy links between different plants, animals, and other organisms in an ecosystem*
* ecosystem: a group of organisms in an area that interact with one another, together with their nonliving environment

Interdependence of Life and Evolution

7.4.6 Explain how food provides the fuel and the building material for all organisms.

7.4.7 Describe how plants use the energy from light to make sugars from carbon dioxide and water to produce food that can be used immediately or stored for later use.

7.4.8 Describe how organisms that eat plants break down the plant structures to produce the materials and energy that they need to survive, and in turn, how they are consumed by other organisms.

7.4.9 Understand and explain that as any population of organisms grows, it is held in check by one or more environmental factors. These factors could result in depletion of food or nesting sites and/or increased loss to increased numbers of predators or parasites. Give examples of some consequences of this.

Human Identity

7.4.10 Describe how technologies having to do with food production, sanitation, and disease prevention have dramatically changed how people live and work and have resulted in changes in factors that affect the growth of human population.

7.4.11 Explain that the amount of food energy (calories) a person requires varies with body weight, age, sex, activity level, and natural body efficiency. Understand that regular exercise is important to maintain a healthy heart/lung system, good muscle tone, and strong bone structure.

7.4.12 Explain that viruses, bacteria, fungi, and parasites may infect the human body and interfere with normal body functions. Recognize that a person can catch a cold many times because there are many varieties of cold viruses that cause similar symptoms.

7.4.13 Explain that white blood cells engulf invaders or produce antibodies that attack invaders or mark the invaders for killing by other white blood cells. Know that the antibodies produced will remain and can fight off subsequent invaders of the same kind.

7.4.14 Explain that the environment may contain dangerous levels of substances that are harmful to human beings. Understand, therefore, that the good health of individuals requires monitoring the soil, air, and water as well as taking steps to keep them safe.

Standard 5

The Mathematical World

Students apply mathematics in scientific contexts. They use mathematical ideas, such as relations between operations, symbols, statistical relationships, and the use of logical reasoning, in the representation and synthesis of data.

Numbers

7.5.1 Demonstrate how a number line can be extended on the other side of zero to represent negative numbers and give examples of instances where this is useful.

Shapes and Symbolic Relationships

7.5.2 Illustrate how lines can be parallel, perpendicular, or oblique.

7.5.3 Demonstrate how the scale chosen for a graph or drawing determines its interpretation.

Reasoning and Uncertainty

7.5.4 Describe that the larger the sample, the more accurately it represents the whole. Understand, however, that any sample can be poorly chosen and this will make it unrepresentative of the whole.

Standard 6

Historical Perspectives

Students gain understanding of how the scientific enterprise operates through examples of historical events. Through the study of these events, they understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators.

7.6.1 Understand and explain that throughout history, people have created explanations for disease. Note that some held that disease had spiritual causes, but that the most persistent biological theory over the centuries was that illness resulted from an imbalance in the body fluids. Realize that the introduction of germ theory by Louis Pasteur and others in the nineteenth century led to the modern understanding of how many diseases are caused by microorganisms, such as bacteria, viruses, yeasts, and parasites.

7.6.2 Understand and explain that Louis Pasteur wanted to find out what caused milk and wine to spoil. Note that he demonstrated that spoilage and fermentation* occur when microorganisms enter from the air, multiply rapidly, and produce waste products, with some desirable results, such as carbon dioxide in bread dough, and some undesirable, such as acetic acid in wine. Understand that after showing that spoilage could be avoided by keeping germs out or by destroying them with heat, Pasteur investigated animal diseases and showed that microorganisms were involved in many of them. Also note that other investigators later showed that specific kinds of germs caused specific diseases.

7.6.3 Understand and explain that Louis Pasteur found that infection by disease organisms (germs) caused the body to build up an immunity against subsequent infection by the same organisms. Realize that Pasteur then demonstrated more widely what Edward Jenner had shown for smallpox without understanding the underlying mechanism: that it was possible to produce vaccines that would induce the body to build immunity to a disease without actually causing the disease itself.

7.6.4 Understand and describe that changes in health practices have resulted from the acceptance of the germ theory of disease. Realize that before germ theory, illness was treated by appeals to supernatural powers or by attempts to adjust body fluids through induced vomiting or bleeding. Note that the modern approach emphasizes sanitation, the safe handling of food and water, the pasteurization of milk, quarantine, and aseptic surgical techniques to keep germs out of the body; vaccinations to strengthen the body's immune system against subsequent infection by the same kind of microorganisms; and antibiotics and other chemicals and processes to destroy microorganisms.

* fermentation: the chemical decomposition of an organic substance

Standard 7

Common Themes

Students analyze the relationships within systems. They investigate how different models can represent the same data, rates of change, cyclic changes, and changes that counterbalance one another.

Systems

7.7.1 Explain that the output from one part of a system, which can include material, energy, or information, can become the input to other parts and this feedback can serve to control what goes on in the system as a whole.

Models and Scale

7.7.2 Use different models to represent the same thing, noting that the kind of model and its complexity should depend on its purpose.

Constancy and Change

7.7.3 Describe how physical and biological systems tend to change until they reach equilibrium and remain that way unless their surroundings change.

7.7.4 Use symbolic equations to show how the quantity of something changes over time or in response to changes in other quantities.